SPACECRAFT OUTGASSING AND SUBSEQUENT AFFECTS ON IN SITU MEASUREMENTS OF LUNAR EXOSPHERIC WATER. W. M. Farrell[1], J. S. Halekas[2], D. M. Hurley[3], J. R. Szalay[4], 1. NASA/Goddard Space Flight Center, Greenbelt MD, 2. University of Iowa, Iowa city, IA, 3. Johns Hopkins University/Applied Physics Laboratory, Laurel, MD, 4. Princeton University, Princeton, NJ

Introduction: The modern mass spectrometer is a very sensitive instrument placed on an outgassing platform. Spacecraft outgas volatiles, especially water, that can define the sensitivity of the instrument. During the early desorption and diffusion phases of spacecraft outgassing, there will be an exponential decay of the outgassing water with the exponential decay time 1-2 months [Schlappi et al., 2010]. Thus, for the first 100-200 days of a mission, the detection of lunar exospheric water may be limited by the contaminating effect of the spacecraft outgassing water.

Robertson [1976] describes two ways in which outgassing water molecules scattered back toward the spacecraft (and thus into a ram-facing mass spectrometer): (1) Self-scattering via water-water collisions in the outgassing cloud itself and (2) water-exosphere collisions in the case where the outgassing water cloud is pass through a tenuous gas.

In the latter situation, the ratio of the water flux backscattered toward the spacecraft compared to that outgassed, $F_{backscat}/F_{out}$, is approximately equal to ~ 0.84 n_{exo} σ_{exo} R S_b where n_{exo} is the ambient neutral exosphere density, σ_{exo} is the exosphere atom collision cross section, R is the size of the spacecraft, and S_b the ratio of the flow speed of the water cloud to its thermal velocity. For any spacecraft passing < 50 km over the lunar surface and deep into the lunar exosphere, we find that $F_{backscat}/F_{out} \sim 10^{-7}$.

Application. This backscattered flux, $F_{backscat}$, then determines an in situ senor sensitivity. For example, for an ideal, ram-facing mass spectrometer (with no internal water contamination and field of view unobstructed by any spacecraft system), the sensitivity of the instrument is then defined by the return flux of the backscattered spacecraft outgassing cloud.

We present estimates for the self-scattering of an outgassing cloud. We then define where the spacecraft enters into the lunar exosphere environment and begins to undergo increased outgassed water backscattering due to water-exosphere collisions – comparing the two effects.

We also present herein requirements on the spacecraft outgassing flux to ensure detection of native exospheric neutral water at the Moon or any airless body via an in situ detection system. We show that the instrument requirement on the detection level of exospheric water directly connects into a mission-level requirement on spacecraft outgassing flux – the two are intimately tied.

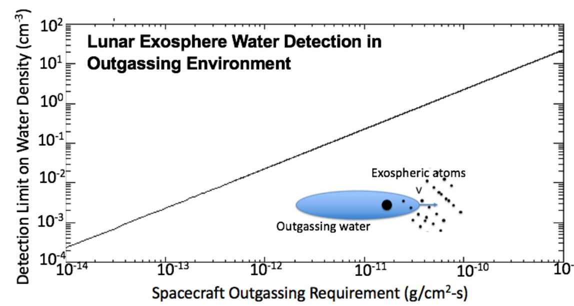

Figure 1- Outgassing and water detection sensitivity for an in situ system like a mass spectrometer